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TEST AND DEMONSTRATION REPORT ON SINGLE AND THREE PHASE
60 TO 400 HZ SLEE. (U) GULTON INDUSTRIES INC HAWTHORNE
CALIF ENGINEERED MAGNETICS DI. J RANCE 28 MAR 79

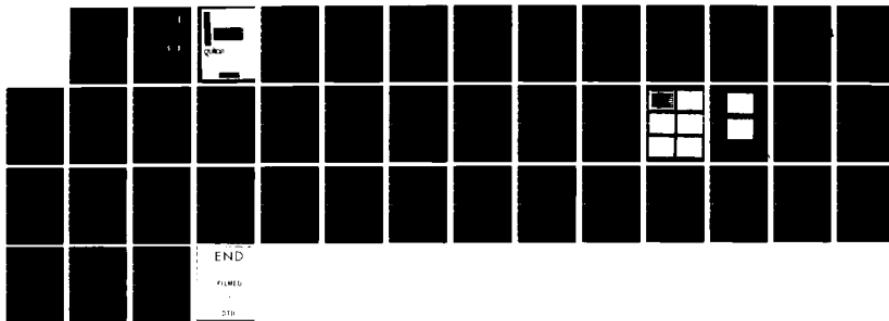
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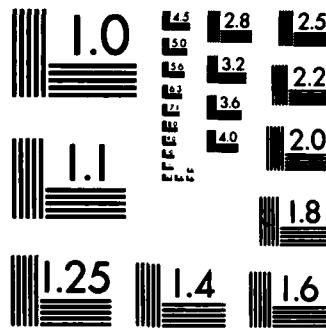
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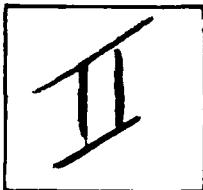


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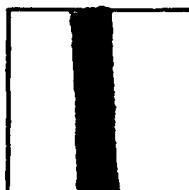
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INVENTORY

Test and Demonstration Report on Single and Three
Phase 60 to 400 Hz Sleep Inverter 3.75KVA Gulton Model
EMIR302

DOCUMENT IDENTIFICATION

Rept. No. 2975

Contract DAAK20-77-C-0012

20 Mar. 79

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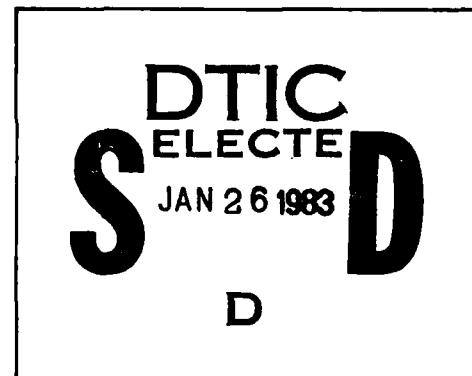
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GULTON MODEL EMR302

3.75KVA

60 TO 400 Hz SLEEP INVERTER
SINGLE AND THREE PHASE

ON

TEST AND DEMONSTRATION REPORT

REPORT NO. 2975

CONTRACT NO. DAK70-77-C0012

DATE: March 20, 1979

PREFACE

This Test and Demonstration Report presents the Test Plan and the results of the tests performed on SLEEP Inverter, Gulton Model EMIR302.

The objective of the overall program is to design, develop, fabricate and test the 120V, 60 to 400Hz, 3.75KVA SLEEP Inverter in accordance with the requirements of U. S. Army Mobility Equipment Research and Development Command Specification EED 76 022501.

The program is being conducted as authorized under the U. S. Army Mobility Equipment Research and Development Command Contract No. DAAK70-77-C0012.

DISCUSSION

The tests were performed per Test Plan with the results recorded on applicable data sheets. The Test Plan is located on the following pages. The completed test data sheets are located in Appendix I.

Summary of Tests

Test	Data Sheet App I, Page...	Remarks
1. Insulation Resistance	1	Passed
2. Voltage Adjustment	2 thru 7	Passed
3. Voltage Unbalance with Unbalanced Load	8	Passed
4. Long Term Voltage and Frequency Stability	9	Passed
5. Frequency Stability and Transient Response	10	Passed
6. Voltage Dip and Rise for Rated Load	11 thru 14	Passed
7. High Temperature	15 thru 20	Passed
8. Voltage Waveform	21, 22	Passed
9. Short Circuit	23	Passed
10. Voltage Modulation	24	Passed
11. DC Content of Output (See Note 1)	--	--
12. Efficiency Test	26 thru 33	80% vs 85% Passed required

NOTE 1: The DC Content of Output, Test 11, was not performed because the GFE filter was not available at the time of test. This test will be performed by personnel at Ft. Belvoir.

The results of the test indicate the Inverter performed within the required specifications and design goals, except for efficiency.

EMIR302 TEST PLAN

1.0 INSULATION RESISTANCE

- 1.1 Apply a megger, set for 200VDC, between unit terminal L0 and unit chassis.
- 1.2 Repeat paragraph 1.1 for L1, L2, L3, +input and -input terminals, except when applying voltage to +input and -input, set megger to 100VDC. Record the insulation resistance after megger voltage has been impressed for 1 minute.

NOTE: Input voltage for tests of paragraphs 2.0 through 10.0 shall be 40VDC.

2.0 VOLTAGE ADJUSTMENT

- 2.1 Operate unit at rated voltage and rated load with outputs connected in 3Ø, 4 wire configuration until unit stabilizes. Frequency shall be 60Hz.
- 2.2 When stabilization has been obtained, record readings on Data Sheet 2.
- 2.3 Remove load and record readings.
- 2.4 Adjust terminal voltage for 10% above rated voltage and record readings.
- 2.5 Apply rated load and record readings.
- 2.6 Remove load and adjust terminal voltage for maximum attainable voltage. Record readings.
- 2.7 Apply rated load and record readings.
- 2.8 Adjust terminal voltage for 10% below rated voltage and record readings.
- 2.9 Remove load and record readings.
- 2.10 Repeat 2.2 through 2.8 for 1Ø, 3 wire and 1Ø, 2 wire voltage connection.
- 2.11 Repeat 2.1 through 2.10 at frequency of 400Hz.

3.0 VOLTAGE UNBALANCE WITH UNBALANCED LOAD

- 3.1 Operate unit at rated voltage and no load in 3Ø, 4 wire configuration. Frequency shall be 60Hz.
- 3.2 Apply unbalanced load to L1-L2 and record readings.

- 3.3 Apply unbalanced load to L2-L3 and record readings.
- 3.4 Apply unbalanced load to L3-L1 and record readings.
- 3.5 Repeat 3.1 through 3.4 at 400Hz frequency.

4.0 LONG TERM VOLTAGE AND FREQUENCY STABILITY

- 4.1 Unit shall operate in the parallel mode. Operate unit at rated voltage and rated load. Frequency shall be 60Hz. Record readings every 10 minutes until unit has stabilized.
- 4.2 After unit has stabilized, record readings every 30 minutes for 2 hours.
- 4.3 After 2 hours, remove load and allow unit to stabilize.
- 4.4 When unit has stabilized, record readings every 30 minutes for 2 hours.
- 4.5 After 2 hours, apply the following load conditions for a minimum of 40 sec.

1) Rated Load	4) No Load
2) No Load	5) Rated Load
3) Rated Load	6) No Load
- 4.6 Determine frequency and voltage stability by comparing readings at time 0 with maximum excursion from these readings.

5.0 FREQUENCY STABILITY AND TRANSIENT RESPONSE

- 5.1 Unit shall operate in the parallel mode. Frequency shall be 60Hz. Operate unit at rated voltage and rated load until unit stabilizes.
- 5.2 After stabilization operate unit at each load condition shown on Data Sheet 5 for a minimum of 40 sec.
- 5.3 Display one cycle of voltage waveform on scope and observe change in frequency of waveform when load is changed. Use formulas on Data Sheet 6 to compute undershoot and overshoot.
- 5.4 Set frequency meter to .1 sec sample rate to observe frequency recovery after a load change. Record readings.

6.0 VOLTAGE DIP AND RISE FOR RATED LOAD

- 6.1 Unit shall operate in the 3Ø, 4 wire mode. Allow unit to stabilize at rated load and rated voltage. Frequency shall be 60Hz.

- 6.2 Remove the load and photograph the voltage transient rise resulting for one phase. Record recovery time.
- 6.3 Reapply the load and photograph the voltage transient dip resulting. Record recovery time.
NOTE: Perform 6.2 and 6.3 for each phase, photographing one rise and one dip per phase (6 photos).
- 6.4 Operate unit in the parallel mode. Remove the load and photograph the total output voltage transient rise (1 photo). Record recovery time.
- 6.5 Reapply the load and photograph total output voltage transient dip (1 photo). Record recovery time.
- 6.6 Compute rise and dip from formulas on Data Sheet.

7.0 HIGH TEMPERATURE

- 7.1 Place unit in chamber and stabilize chamber at +125°F.
- 7.2 Operate unit at rated voltage and rated load. Frequency shall be 400Hz.
- 7.3 Repeat paragraphs 2.0, 4.0, 5.0, 6.0. Use Data Sheet 7 to record results for paragraph 2.0, use duplicate data sheets 4, 5 and 6 to record results of paragraphs 4.0, 5.0, and 6.0.

8.0 VOLTAGE WAVEFORM

- 8.1 Unit shall operate in the parallel mode. Operate unit at rated voltage and rated load. Frequency shall be 60Hz.
- 8.2 Read and record all harmonics in excess of .05% of the fundamental. Scan all harmonics to 50th harmonic.
- 8.3 Photograph waveform.
- 8.4 Read and record maximum deviation factor.
- 8.5 Repeat 8.2 through 8.4 for 1/2 rated load, no load and rated at .8PF.
- 8.6 Repeat 8.1 through 8.5 at 400Hz frequency.

9.0 SHORT CIRCUIT

- 9.1 Operate unit at rated voltage, rated load, 60Hz. Voltage connection shall be 1Ø, 2 wire. Record voltage and current.
- 9.2 Apply L1-L0 short for 10 sec. Record short circuit current.
- 9.3 Change voltage connection to 1Ø, 3 wire. Record voltage and currents.

- 9.4 Apply L1-L0, L2-L0, L1-L2 short for 10 sec. Record L1 and L2 short circuit currents.
- 9.5 Change voltage connection to 3Ø, 4 wire. Record voltages and currents.
- 9.6 Apply L1-L0, L2-L0, L3-L0 short for 10 sec. Record short circuit currents.
- 9.7 Repeat 9.1 through 9.6 at 400Hz.

10.0 VOLTAGE MODULATION

- 10.1 Operate unit at rated voltage and rated load. Voltage connection shall be 3Ø, 4 wire. Frequency shall be 60Hz.
- 10.2 Take photograph of top of sine wave to observe voltage modulation between adjacent peaks. Record displacement between adjacent peaks.
- 10.3 Repeat 10.2 for no load and rated at .8PF.
- 10.4 Repeat 10.2 and 10.3 for 1Ø, 3 wire and 1Ø, 2 wire connection.
- 10.5 Repeat 10.2 through 10.4 at 400Hz frequency.

11.0 DC CONTENT OF OUTPUT

- 11.1 Connect the GFE filter between the Inverter output and the load in parallel mode configuration.
- 11.2 Operate unit at 1/2 rated load and 40VDC input. The output frequency shall be 60Hz.
- 11.3 Measure and record the DC content of the AC output using the digital voltmeter for each output phase.
- 11.4 Repeat 11.3 at N/L, rated and .8PF rated.
- 11.5 Repeat 11.2 and 11.3 at 400Hz output frequency.

12.0 EFFICIENCY TEST

- 12.1 Record the data as required by Data Sheet 12.
- 12.2 Calculate output power, power factor and efficiency. Use formulas state on Data Sheet 12.

APPENDIX I
TEST DATA SHEETS

SN-57812

1. INSULATION RESISTANCE

TERMINAL TO CHASSIS	INSULATION RESISTANCE	MEGGER VOLTAGE
L0	>100 MEG	200V
L1	>100 MEC	200V
L2	>100 MEC	200V
L3	>100 MEC	200V
+ INPUT	>100 MEC	100V
- INPUT	>100 MEC	100V

>10MEG

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2. VOLTAGE ADJUSTMENT

(Output Connected in 3Ø, 4 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-L0	L2-L0	L3-L0	L1	L2	L3	
RATED	120.2	120.2	120.5	8.36	8.35	8.31	60.01
N/L	120.2	120.0	120.0	0	0	0	59.99
N/L	132.2	132.2	132.1	0	0	0	59.99
RATED	132.1	132.3	132.4	9.14	9.23	9.14	59.99
N/L	135.2	135.1	135.1	0	0	0	59.99
RATED	134.7	135.1	135.4	9.37	9.44	9.37	59.99
RATED	108.1	108.1	108.4	7.53	7.56	7.48	60.00
N/L	108.1	108.0	107.9	0	0	0	59.99

ADJUSTMENT $\pm 10\%$ 60Hz $\pm .3\text{Hz}$
 REGULATION 2%

-26-

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I-2

2. VOLTAGE ADJUSTMENT

(Output Connected in 1Ø, 3 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-L0	L2-L0	L3-L0	L1	L2	L3	
RATED	120.0	120.2	-	8.42	16.72	-	60.02
N/L	120.2	120.1	-	0	0	-	59.97
N/L	132.1	132.4	-	0	0	-	59.97
RATED	131.8	132.0	-	9.18	18.22	-	60.00
N/L	135.3	135.8	-	0	0	-	59.99
RATED	133.8	134.9	-	9.33	18.65	-	59.99
RATED	108.0	108.1	-	7.57	14.97	-	60.04
N/L	108.1	108.0	-	0	0	-	59.99

ADJUSTMENT $\pm 10\%$ 60Hz $\pm .3\text{Hz}$

REGULATION 2%

-6A- 

2. VOLTAGE ADJUSTMENT

(Output Connected in 1Ø, 2 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-L0	L2-L0	L3-L0	L1	L2	L3	
RATED	120.0	-	-	24.75	-	-	60.01
N/L	120.0	-	-	0	-	-	60.02
N/L	132.4	-	-	0	-	-	59.99
RATED	131.8	-	-	27.33	-	-	60.03
N/L	135.7	-	-	0	-	-	59.99
RATED	134.6	-	-	27.97	-	-	59.99
RATED	108.0	-	-	22.48	-	-	60.03
N/L	108.1	-	-	0	-	-	59.99

ADJUSTMENT $\pm 10\%$ 60Hz $\pm .3\text{Hz}$

REGULATION 2%

-6B-

3LE
E

2. VOLTAGE ADJUSTMENT

(Output Connected in 3Ø, 4 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-L0	L2-L0	L3-L0	L1	L2	L3	
RATED	120.1	120.2	120.4	8.28	8.34	8.21	400.03
N/L	120.1	119.9	119.5	0	0	0	399.94
N/L	132.1	132.2	131.8	0	0	0	399.93
RATED	131.9	132.3	132.3	9.08	9.14	9.00	400.50
N/L	134.3	134.8	134.2	0	0	0	399.94
RATED	134.3	135.2	135.8	9.31	9.36	9.20	399.97
RATED	108.0	108.0	108.2	7.47	7.50	7.40	400.13
N/L	108.0	107.7	107.4	0	0	0	399.93

ADJUSTMENT $\pm 10\%$ 400Hz $\pm 2\text{Hz}$
 REGULATION 2%

-SC-

TOP
ONE
6

2. VOLTAGE ADJUSTMENT

(Output Connected in 1Ø, 3 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-L0	L2-L0	L3-L0	L1	L2	L3	
RATED	120.2	120.1	-	8.30	16.49	-	400.04
N/L	120.0	119.5	-	0	0	-	399.93
N/L	132.1	132.0	-	0	0	-	399.93
RATED	132.1	132.1	-	9.12	18.12	-	400.01
N/L	134.9	135.2	-	0	0	-	399.93
RATED	135.4	134.7	-	9.32	18.51	-	399.46
RATED	108.1	107.8	-	7.46	14.83	-	400.09
N/L	107.8	107.3	-	0	0	-	399.93

ADJUSTMENT ±10% 400Hz ±2Hz

REGULATION 2%

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2. VOLTAGE ADJUSTMENT

(Output Connected in 1Ø, 2 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-LO	L2-LO	L3-LO	L1	L2	L3	
RATED	129.2	-	-	24.89	-	-	400.00
N/L	120.1	-	-	0	-	-	399.93
N/L	132.1	-	-	0	-	-	399.93
RATED	131.7	-	-	27.15	-	-	400.01
N/L	135.2	-	-	0	-	-	399.93
RATED	134.5	-	-	27.75	-	-	399.96
RATED	107.9	-	-	22.29	-	-	400.13
N/L	107.7	-	-	0	-	-	399.93

ADJUSTMENT $\pm 10\%$ 400Hz $\pm 2\text{Hz}$

REGULATION 2%

3. VOLTAGE UNBALANCE WITH UNBALANCED LOAD
(Output Connected in 3Ø, 4 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-L0	L2-L0	L3-L0	L1	L2	L3	
L1-L2 LOADED	120.2	120.0	120.4	1.82	1.82	0	60
L2-L3 LOADED	120.6	120.2	120.0	0	1.82	1.82	60
L3-L1 LOADED	120.1	120.4	120.1	1.82	0	1.82	60
L1-L2 LOADED	119.9	119.6	119.7	1.82	1.80	0	400
L2-L3 LOADED	120.4	119.9	119.5	0	1.82	1.81	400
L3-L1 LOADED	119.9	120.0	119.7	1.81	0	1.82	400

VOLTAGE UNBALANCE 1%

60 Hz - ± .3Hz

400 Hz - ± 2Hz

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4. LONG TERM VOLTAGE AND FREQUENCY STABILITY
 (Output Connected in Parallel Mode of Operation)

TIME	LOAD	VOLTAGE	CURRENT	FREQ
0	RATED	119.9	24.90	60.03
10 MIN	RATED	119.9	24.88	60.03
20 MIN	RATED	119.9	24.84	60.03
30 MIN	RATED	119.9	24.86	60.03
STABILIZED	RATED	119.9	24.86	60.03
0	RATED	119.9	24.86	60.03
30 MIN	RATED	120.0	24.87	60.03
1 HR	RATED	120.0	24.87	60.03
1-1/2 HR	RATED	120.0	24.87	60.03
2 HR	RATED	120.0	24.87	60.03
STABILIZED	N/L	120.1	0	59.99
0	N/L	120.1	0	59.99
30 MIN	N/L	120.1	0	59.99
1 HR	N/L	120.0	0	59.99
1-1/2 HR	N/L	120.0	0	59.99
2 HR	N/L	120.0	0	59.99
40 SEC	RATED	119.9	24.89	60.03
40 SEC	N/L	120.0	0	59.99
40 SEC	RATED	119.9	24.90	60.03
40 SEC	N/L	120.0	0	59.99
40 SEC	RATED	119.9	24.90	59.99
40 SEC	N/L	120.0	0	60.03

VOLTAGE REGULATION: 2%, VOLTAGE STABILITY: 2%, FREQ. STABILITY: 1%

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TYPE B

5. FREQUENCY STABILITY AND TRANSIENT RESPONSE

(SHORT-TERM)

(Output Connected in Parallel Mode of Operation)

LOAD	OVERSHOOT		UNDERSHOOT		FREQ
	FREQ	RECOVERY	FREQ	RECOVERY	
RATED	-	-	-	-	60.00
N/L	.02%	<.15	-	-	59.99
RATED	-	-	.05%	<.15	60.02
N/L	.05%	<.15	-	-	59.99
RATED	-	-	.05%	<.15	60.02
N/L	.05%	<.15	-	-	59.99
RATED	-	-	.05%	<.15	60.02
N/L	.05%	<.15	-	-	59.99
3/4 RATED	-	-	.03%	<.15	60.01
N/L	.03%	<.15	-	-	59.99
3/4 RATED	-	-	.03%	<.15	60.01
N/L	.03%	<.15	-	-	59.99
3/4 RATED	-	-	.03%	<.15	60.01
N/L	.03%	<.15	-	-	59.99
1/2 RATED	-	-	.02%	<.15	60.00
N/L	.02%	<.15	-	-	59.99
1/2 RATED	-	-	.02%	<.15	60.00
N/L	.02%	<.15	-	-	59.99
1/4 RATED	-	-	.02%	<.15	60.00
N/L	.02%	<.15	-	-	59.99
1/4 RATED	-	-	.02%	<.15	60.00
N/L	.02%	<.15	-	-	59.99
1/4 RATED	-	-	.02%	<.15	60.00
N/L	.02%	<.15	-	-	59.99
RATED	-	-	.05%	<.15	60.02
N/L	.05%	<.15	-	-	59.99
RATED	-	-	.05%	<.15	60.02
N/L	.05%	<.15	-	-	59.99
RATED	-	-	.05%	<.15	60.02
N/L	.05%	<.15	-	-	59.99

UNDERSHOOT: 4%

OVERSHOOT: 4%

RECOVERY: 4SEC

FREQUENCY STABILITY: 0.5%

FREQUENCY RANGE:

0Hz: ±.3Hz

40Hz: ±2Hz



6. VOLTAGE DIP AND RISE FOR RATED LOAD
(Output Connected in 3φ, 4 Wire Operation)

LOAD	L1-LO	L2-LO	L3-LO	L1-LO	L2-LO	L3-LO	FREQ.
VOLTAGE	DIP	RECOVERY	DIP	RECOVERY	RISE	RECOVERY	
TO N/L RATED	-	-	-	-	1/.7	1.4	1.4
N/L TO RATED	10.7	.3	10.7	.3	-	-	60.03 Hz

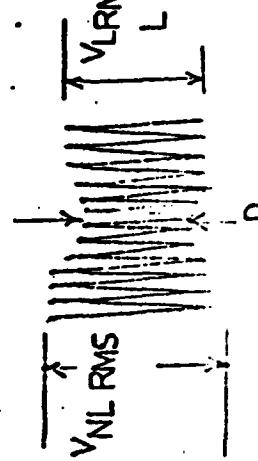
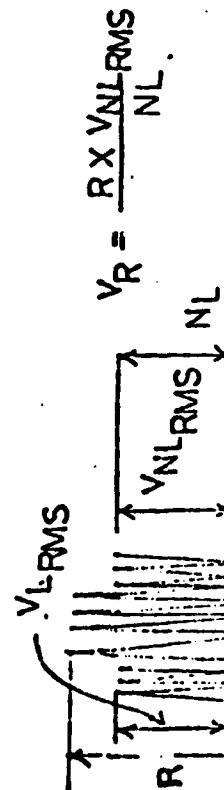
20% 3SEC

(Output Connected in Parallel Mode)

VOLTAGE	DIP	RECOVERY	RISE	RECOVERY	FREQ.
RATED TO N/L	-	-	1/.7	1.4	60.03 Hz
N/L TO RATED	10.7	.3	-	-	

20% 3SEC 20% 3SEC

Y-11



$$\text{DIP} = \frac{V_{NL\text{ RMS}} - V_C}{120V\text{ RMS}}$$

APPLY LOAD

REMOVE LOAD

DEFINITIONS OF SYMBOLS
USED ON DATA SHEET 6

- $V_{NL,RMS}$ = Steady-state voltmeter reading at no load prior to applying load and after removing load.
- V_D = Calculated voltage dip during the transient period.
- $V_{L,RMS}$ = Steady-state voltmeter reading after application of load.
- D = Measured minimum peak-to-peak amplitude of the AC voltage trace during the transient period following load application.
- L = Measured amplitude, peak-to-peak for AC, of the steady-state voltage after load application.
- V_R = Calculated voltage rise during the transient period.
- R = Measured maximum peak-to-peak amplitude of the AC voltage trace during the transient period following load removal.
- N_L = Measured amplitude, peak-to-peak for AC, of the steady-state voltage after removing load.
- $V_{L,RMS}$ = Steady-state voltmeter reading prior to removing load.

-10A-

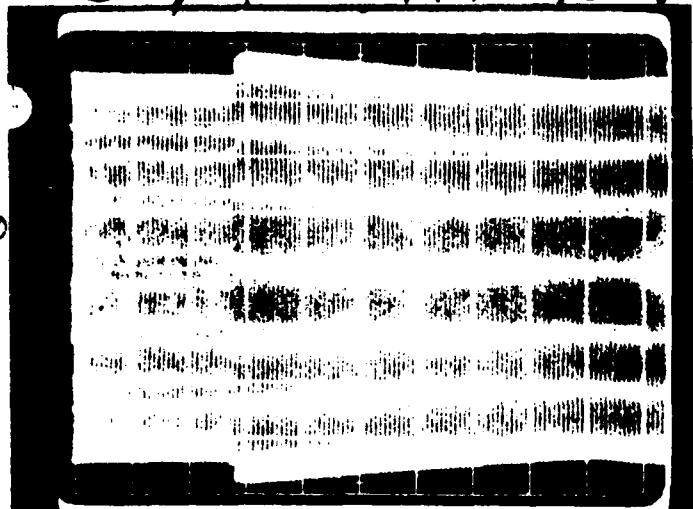
I-12

50V/cm

R TO N/L φA

50V/cm

N/L ~~2.5 sec~~ TO RATED



60Hz Unity PF .2sec sweep

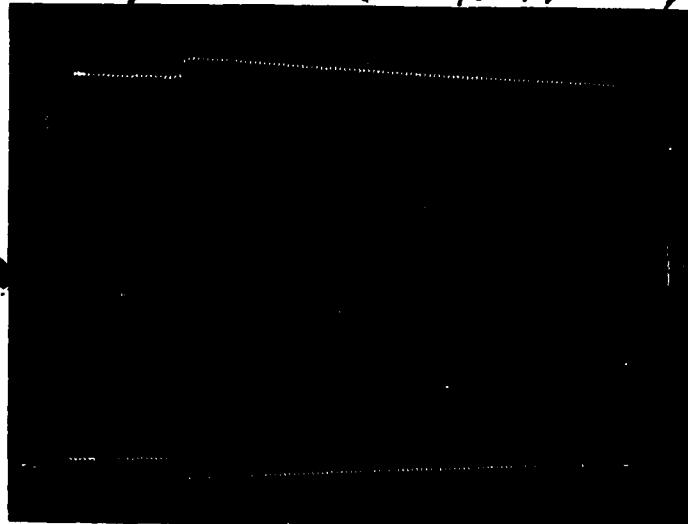
50V/cm

Rated TO N/L φB

60Hz Unity PF .2 sec Sweep

50V/cm

NL TO Rated



60Hz Unity .2sec sweep

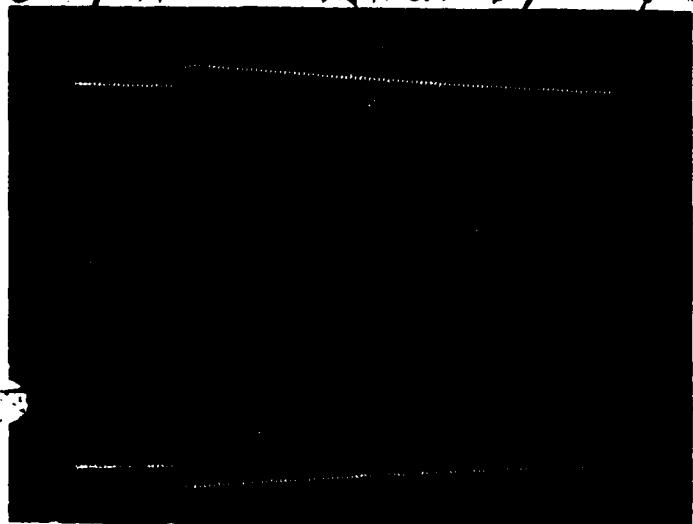
50V/cm

Rated TO N/L φC

60Hz Unity .2 Sec Sweep

50V/cm

NL TO Rated φC



60Hz

.2 sec Sweep

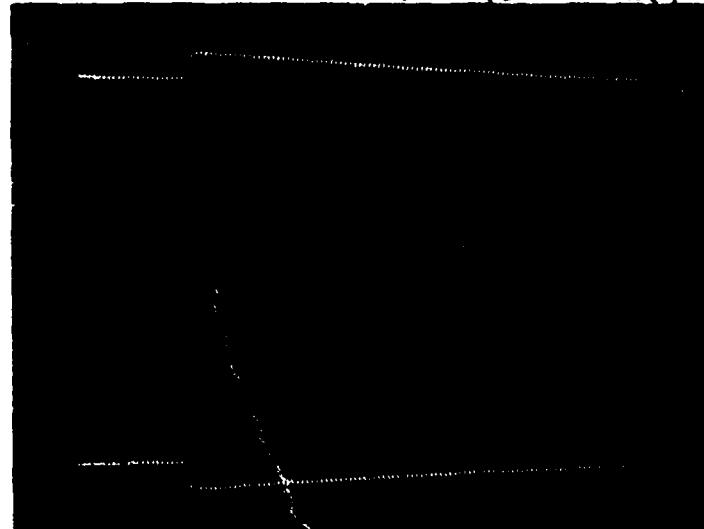
I-13

60Hz Unity .2 sec Sweep

I-13

50V/cm

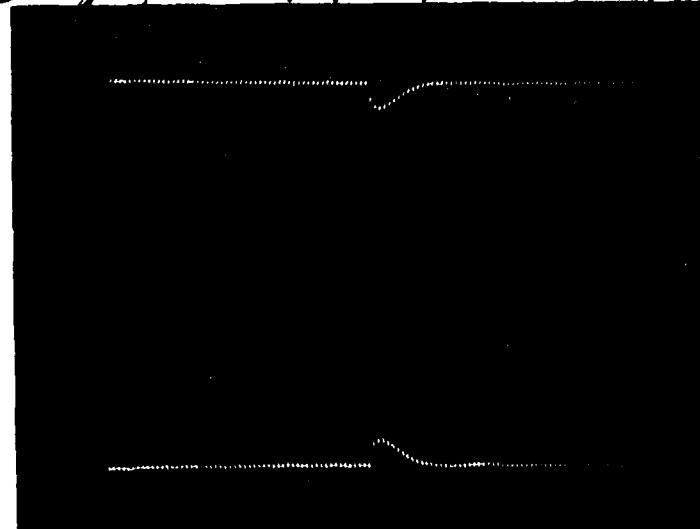
RATED TO N/L PARALLEL



60Hz Unity .2 sec sweep

50V/cm

N/L TO RATED PARALLEL



60Hz Unity .2 sec sweep

2. VOLTAGE ADJUSTMENT *(HIGH TEMP)*

(Output Connected in 3Ø, 4 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-L0	L2-L0	L3-L0	L1	L2	L3	
RATED	119.6	119.6	119.7	8.33	8.40	8.26	400.02
N/L	119.7	119.4	119.1	0	0	0	399.94
N/L	132.0	132.2	131.6	0	0	0	399.93
RATED	132.1	132.2	132.2	9.09	9.12	9.01	400.02
N/L	134.7	135.3	134.6	0	0	0	399.93
RATED	134.7	134.7	134.7	9.31	9.35	9.22	400.02
RATED	108.1	108.0	108.1	7.47	7.48	7.40	400.04
N/L	108.0	107.7	107.4	0	0	0	399.93

ADJUSTMENT $\pm 10\%$ 400Hz $\pm 2\text{Hz}$
 REGULATION 2%

26C-



2. VOLTAGE ADJUSTMENT (HIGH TEMP)

(Output Connected in 1Ø, 3 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-LO	L2-LO	L3-LO	L1	L2	L3	
RATED	120.0	119.8	-	8.33	16.66	-	400.02
N/L	119.8	119.2	-	0	0	-	399.97
N/L	132.1	132.1	-	0	0	-	399.93
RATED	132.3	132.1	-	9.13	18.13	-	400.02
N/L	134.7	135.0	-	0	0	-	399.93
RATED	134.8	134.6	-	9.31	18.51	-	400.01
RATED	108.0	107.7	-	7.44	14.81	-	400.01
N/L	107.8	107.3	-	0	0	-	399.93

ADJUSTMENT $\pm 10\%$ 400Hz $\pm 2\text{Hz}$
REGULATION 2%

-6D-



2. VOLTAGE ADJUSTMENT (HIGH TEMP)

(Output Connected in 1Ø, 2 Wire Operation)

LOAD	VOLTAGE			CURRENT			FREQ
	L1-L0	L2-L0	L3-L0	L1	L2	L3	
RATED	120.0	-	-	25.1	-	-	400.07
N/L	120.0	-	-	0	-	-	399.93
N/L	132.06	-	-	0	-	-	399.93
RATED	131.9	-	-	27.2	-	-	400.01
N/L	135.10	-	-	0	-	-	399.93
RATED	134.3	-	-	22.8	-	-	399.70
RATED	108.0	-	-	22.3	-	-	400.09
N/L	107.9	-	-	0	-	-	399.97

ADJUSTMENT $\pm 10\%$ 400Hz $\pm 2\text{Hz}$

REGULATION 2%

-6E-  1

4. LONG TERM VOLTAGE AND FREQUENCY STABILITY (HIGH TEMP)
 (Output Connected in Parallel Mode of Operation)

TIME	LOAD	VOLTAGE	CURRENT	FREQ
0	RATED	119.9	25.1	400.10
10 MIN	RATED	119.9	25.1	400.09
20 MIN	RATED	119.9	25.0	400.08
30 MIN	RATED	119.9	25.0	400.09
STABILIZED	RATED	119.9	25.0	400.09
0	RATED	119.9	24.9	400.09
30 MIN	RATED	119.9	24.9	400.11
1 HR	RATED	119.9	24.9	400.09
1-1/2 HR	RATED	119.9	24.9	400.08
2 HR	RATED	120.0	24.9	400.07
STABILIZED	N/L	119.9	0	399.93
0	N/L	119.9	0	399.93
30 MIN	N/L	119.9	0	399.93
1 HR	N/L	119.9	0	399.93
1-1/2 HR	N/L	119.9	0	399.93
2 HR	N/L	119.9	0	399.93
40 SEC	RATED	120.0	25.0	400.06
40 SEC	N/L	119.9	0	399.93
40 SEC	RATED	120.0	25.0	400.07
40 SEC	N/L	119.9	0	399.93
40 SEC	RATED	120.0	25.0	400.08
40 SEC	N/L	119.9	0	399.93

VOLTAGE REGULATION: 2%, VOLTAGE STABILITY: 2%, FREQ. STABILITY: 1%

-8-

TM
MAR
6

5. FREQUENCY STABILITY AND TRANSIENT RESPONSE (HIGH TEMP)
(SHORT-TERM)

(Output Connected in Parallel Mode of Operation)

LOAD	OVERSHOOT		UNDERSHOOT		FREQ
	FREQ	RECOVERY	FREQ	RECOVERY	
RATED	-	-	-	-	400.16
N/L	.06%	<.15	-	-	399.93
RATED	-	-	.06%	<.15	400.16
N/L	.06%	<.15	-	-	399.93
RATED	-	-	.06%	<.15	400.16
N/L	.06%	<.15	-	-	399.93
RATED	-	-	.06%	<.15	400.16
N/L	.06%	<.15	-	-	399.93
3/4 RATED	-	-	.04%	<.15	400.09
N/L	.04%	<.15	-	-	399.93
3/4 RATED	-	-	.04%	<.15	400.09
N/L	.04%	<.15	-	-	399.93
3/4 RATED	-	-	.04%	<.15	400.09
N/L	.04%	<.15	-	-	399.93
1/2 RATED	-	-	.03%	<.15	400.06
N/L	.03%	<.15	-	-	399.93
1/2 RATED	-	-	.03%	<.15	400.06
N/L	.03%	<.15	-	-	399.93
1/2 RATED	-	-	.03%	<.15	400.06
N/L	.03%	<.15	-	-	399.93
1/4 RATED	-	-	.01%	<.15	399.96
N/L	.01%	<.15	-	-	399.93
1/4 RATED	-	-	.01%	<.15	399.96
N/L	.01%	<.15	-	-	399.93
1/4 RATED	-	-	.01%	<.15	399.96
N/L	.01%	<.15	-	-	399.93
RATED	-	-	.06%	<.15	400.16
N/L	.06%	<.15	-	-	399.93
RATED	-	-	.06%	<.15	400.16
N/L	.06%	<.15	-	-	399.93
RATED	-	-	.06%	<.15	400.16
N/L	.06%	<.15	-	-	399.93

UNDERSHOOT: 4%

OVERSHOOT: 4%

RECOVERY: 4SEC

FREQ. STABILITY: 0.5%

FREQ RANGE:

60Hz: $\pm .3\text{Hz}$

400Hz: $\pm 2\text{Hz}$

-9-



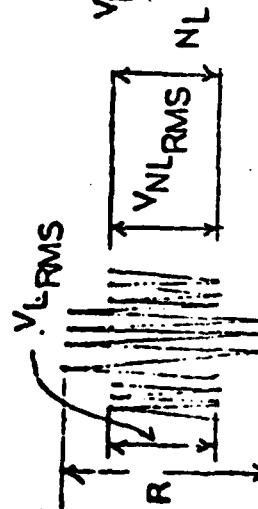
6. VOLTAGE DIP AND RISE FOR RATED LOAD
 (Output Connected in 3φ, 4 Wire Operation) (HIGH TEMP.)

LOAD	L1-LO	L2-LO	L3-LO	L1-LO	L2-LO	L3-LO	FREQ.
VOLTAGE	DIP	RECOVERY	DIP	RECOVERY	DIP	RECOVERY	
RATED	-	-	-	-	-	-	
TO N/L	-	-	-	-	-	-	
N/L TO RATED	.6	.3	.6	.3	.6	.3	322.93Hz
20%	3 SEC						
							3 SEC
							30%

(Output Connected in Parallel Mode)

VOLTAGE	DIP	RECOVERY	RISE	RECOVERY	FREQ
RATED					
TO N/L	-	-	-	-	
N/L TO RATED	.6	.3	.6	.3	322.93Hz
20%	3 SEC	20%	3 SEC		

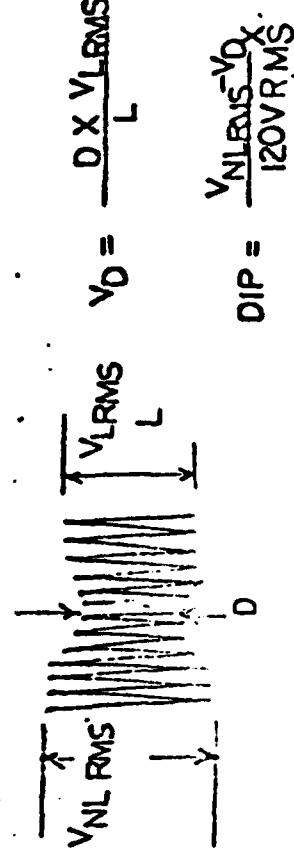
10-20



$$V_R = \frac{R \times V_{NL\text{ RMS}}}{N_L}$$

$$\text{RISE} = \frac{V_R - V_{NL\text{ RMS}}}{120\text{VRMS}} \times 100\%$$

REMOVE LOAD



$$\text{DIP} = \frac{V_{NL\text{ RMS}} - V_D}{120\text{VRMS}}$$

APPLY LOAD

8. VOLTAGE WAVEFORM - SINGLE VOLTAGE HARMONIC
(Output Connected in Parallel Mode of Operation)

LOAD	FUND. HARM..	HARMONICS									
		3	5	7	9	11	13	15	17	19	21
RATED	100%	.97%	.97%	.92%	.92%	.95%	.37%	.32%	.26%	.199%	.152%
1/2 RATED	100%	.4%	.92%	.72%	.86%	.26%	.28%	.24%	.19%	.145%	.06%
N/L	100%	.36%	.84%	1.4%	1.1%	.28%	.34%	.02%	.1.9%	1.48%	.02%
RATED .8 PF	100%	1.65%	1.62%	.92%	.92%	.45%	.28%	.09%	.205%	.06%	.20%
											.28%

60Hz

LOAD	FUND. HARM..	HARMONICS											
		2	3	5	7	9	11	13	15	17	19	21	23
RATED	100%	.26%	1.51%	.87%	.77%	.75%	.46%	.18%	.16%	.182%	.8%	.15%	.13%
1/2	100%	.10%	.77%	.83%	.42%	.78%	.42%	.10%	.13%	.13%	.17%	.85%	.06%
N/L	100%	.13%	.6%	.55%	.1.55%	.6%	.12%	.5%	.02%	.02%	.1.6%	.95%	.02%
RATED .8 PF	100%	.08%	1.9%	2.3%	1.6%	2.1%	.75%	.06%	.19%	.1.85%	.92%	.16%	.11%

40%
H2

H-2

8. VOLTAGE WAVEFORM - DEVIATION FACTOR
 (Output Connected in Parallel Mode of Operation)

LOAD	FREQ	OUTPUT DEVIATION
RATED	60	2.35%
1/2 RATED		2.20%
N/L		2.25%
RATED .8PF		2.95%
RATED	400	2.10%
1/2 RATED		1.90%
N/L		2.11%
RATED .8PF		3.2%

10 - 6%



9. SHORT CIRCUIT

VOLTAGE CONNECTION	FREQ	VOLTAGE				CURRENT			SHORT CIRCUIT CURRENT		
		L1-L2	L1-LO	L2-LO	L3-LO	L1	L2	L3	L1	L2	L3
1Ø - 2 WIRE	60Hz	-	119.9	-	-	24.94	-	-	36.1	-	-
1Ø - 3 WIRE			119.9	120.0	-	8.38	16.69	-	11.5	26.3	-
3Ø - 4 WIRE		-	120.0	120.0	120.0	8.42	8.48	8.33	11.6	14.0	13.2
1Ø - 2 WIRE	400Hz	-	119.6	-	-	24.80	-	-	59.7	-	-
1Ø - 3 WIRE			120.0	120.0	-	8.31	8.33	8.24	17.5	44.6	-
3Ø - 4 WIRE		-	119.9	119.9	120.0	8.32	8.31	8.26	18.3	22.2	22.4

~~-24-~~ 6/20

I-23

10. VOLTAGE MODULATION

			VOLTAGE MODULATION					
VOLTAGE CONNECTION	LOAD	FREQ	L1-L2	L2-L3	L3-L1	L1-L0	L2-L0	L3-L0
3Ø - 4 WIRE	RATED	60Hz	.8V	1.5V	1.4V	.5V	.5V	.5V
	N/L		.2V	.2V	.2V	.1V	.1V	.1V
	RATED .8PF		.8V	1.6V	1.5V	.5V	.6V	1.2V
	RATED	400Hz	2.6V	2.6V	2.6V	1.2V	1.2V	1.5V
	N/L		.2V	.2V	.2V	.1V	.1V	.2V
	RATED .8PF		1.9V	2.2V	1.7V	1.4V	1.6V	1.7V

			VOLTAGE MODULATION		
VOLTAGE CONNECTION	LOAD	FREQ	L1 - L2	L1 - L0	L2 - L0
1Ø - 3 WIRE	RATED	60Hz	.5V	.4V	.4V
	N/L		.1V	.1V	.1V
	RATED .8PF		.6V	.5V	.6V
	RATED	400Hz	1.3V	.9V	.7V
	N/L		.1V	.1V	.1V
	RATED .8PF		1.5V	1.1V	1.2V

			VOLTAGE MODULATION	
VOLTAGE CONNECTION	LOAD	FREQ	L1 - L0	
1Ø - 2 WIRE	RATED	60Hz		.4V
	N/L			.1V
	RATED .8PF			.5V
	RATED	400Hz		.8V
	N/L			.1V
	RATED .8PF			.8V

-25-

10-6
6

**11.0 DC CONTENT OF OUTPUT
(With Filter on Output)**

*Not Performed at (full)
Ft Belvoir facility will
perform.*

(Output Connected in Parallel Mode of Operation)

DC CONTENT OF OUTPUT	OUTPUT FREQ	LOAD COND
	60	RATED
	60	1/2 RATED
	60	N/L
	60	RATED .8PF
	400	RATED
	400	1/2 RATED
	400	N/L
	400	RATED .8PF

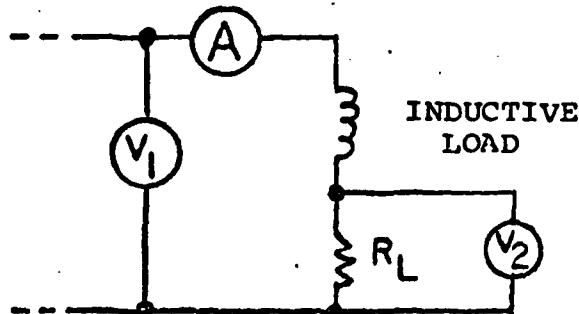
(< 100mV)

-26-

I-25

12.0 EFFICIENCY

AT: 40VDC INPUT
60Hz OUTPUT FREQ



(Output Connected in 3Ø, 4 Wire Operation)

LOAD CONDITION		1/4 RATED UNITY	1/2 RATED UNITY	3/4 RATED UNITY	RATED UNITY	RATED INDUCTIVE
DC INPUT	VOLTS	40.0	40.0	40.0	40.0	40.0
	AMPS	24.74	48.25	70.0	73.5	89.2
	WATTS	989.6	1930.0	2800.0	3732.0	3568.0
AC OUTPUT VOLTS (V1)	L1-L0	-	-	-	-	119.4
	L2-L0	-	-	-	-	119.8
	L3-L0	-	-	-	-	120.0
AC OUTPUT VOLTS (V2)	L1-L0	120.4	120.4	120.3	120.1	93.6
	L2-L0	120.4	120.3	120.2	120.1	93.5
	L3-L0	120.4	120.5	120.5	120.5	93.5
AC OUTPUT AMPS	L1	1.90	4.22	6.27	8.43	10.17
	L2	1.94	4.25	6.33	8.48	10.10
	L3	1.89	4.18	6.28	8.36	10.16
TRUE POWER (V2•A)	L1	228.9	509.1	754.3	1012.4	962.0
	L2	233.6	511.3	760.9	1018.4	944.3
	L3	227.6	503.7	756.7	1007.4	949.9
APPARENT POWER (V1•A)	L1	-	-	-	-	1214.3
	L2	-	-	-	-	1209.9
	L3	-	-	-	-	1218.2
P.F. $\frac{V_2 \cdot A}{V_1 \cdot A}$	L1	-	-	-	-	.79
	L2	-	-	-	-	.78
	L3	-	-	-	-	.78
TOTAL TRUE POWER		689.9	1523	2271.9	3039.3	2856.2
TOTAL APPARENT PWR		-	-	-	-	3642.4
EFFICIENCY (%)		69.7	78.9	81.1	81.4	80.0

$$EFF = \frac{\text{TOTAL TRUE POWER}}{\text{DC INPUT WATTS}} \times 100$$

REGULATION: 2%

AT: 40VDC INPUT
60Hz OUTPUT FREQ

(Output Connected in Parallel Mode of Operation) (1φ 120V, 20W)

LOAD CONDITION		1/4 RATED UNITY	1/2 RATED UNITY	3/4 RATED UNITY	RATED UNITY	RATED INDUCTIVE
DC INPUT	VOLTS	40.0	40.0	40.0	40.0	40.0
	AMPS	24.52	48.56	70.56	93.34	91.1
	WATTS	980.8	1942.4	2822.4	3733.6	3644.0
AC OUTPUT (V ₁)		-	-	-	-	93.8
AC OUTPUT (V ₂)		117.9	120.0	119.9	119.9	119.3
AC OUTPUT AMPS		5.69	12.58	18.79	25.13	30.40
TRUE PWR (V ₂ •A)		682.2	1509.6	2252.9	3013.1	2851.5
APPARENT PWR (V ₁ •A)		-	-	-	-	3626.7
P. (%) (V ₂ •A / V ₁ •A)		-	-	-	-	.79
EFFICIENCY (%)		69.6	77.7	79.8	80.7	78.4

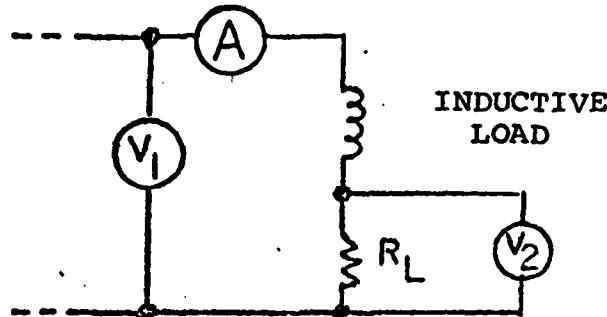
$$\text{EFF} = \frac{\text{TRUE POWER}}{\text{DC INPUT WATTS}} \times 100$$

REGULATION: 2%

-17A-
E.M.C. G-6
I-27

41

AT: 60VDC INPUT
60Hz OUTPUT FREQ



(Output Connected in 3Ø, 4 Wire Operation)

LOAD CONDITION		1/4 RATED UNITY	1/2 RATED UNITY	3/4 RATED UNITY	RATED UNITY	RATED INDUCTIVE
DC INPUT	VOLTS	60.0	60.0	60.0	60.0	60.0
	AMPS	16.85	32.42	47.0	61.94	59.72
	WATTS	1011.0	1945.2	2820.0	3716.4	3571.2
AC OUTPUT VOLTS (V_1)	L1-L0	-	-	-	-	119.4
	L2-L0	-	-	-	-	119.5
	L3-L0	-	-	-	-	119.7
AC OUTPUT VOLTS (V_2)	L1-L0	120.0	120.0	119.9	119.8	94.4
	L2-L0	120.0	120.0	119.8	119.8	93.5
	L3-L0	120.0	120.0	120.0	120.0	93.5
AC OUTPUT AMPS	L1	1.87	4.19	6.23	8.38	10.17
	L2	1.93	4.21	6.30	8.46	10.00
	L3	1.81	4.14	6.24	8.31	10.05
TRUE POWER ($V_2 \cdot A$)	L1	226.8	502.8	746.9	1003.9	960.0
	L2	231.6	505.2	754.7	1011.1	935.0
	L3	223.2	496.8	748.8	997.2	939.7
APPARENT POWER ($V_1 \cdot A$)	L1	-	-	-	-	1214.3
	L2	-	-	-	-	1195.0
	L3	-	-	-	-	1203.0
$\frac{P.F.}{V_2 \cdot A}$ $\frac{V_2 \cdot A}{V_1 \cdot A}$	L1	-	-	-	-	.79
	L2	-	-	-	-	.78
	L3	-	-	-	-	.78
TOTAL TRUE POWER	681.6	1504.8	2250.5	3012.2	2834.7	
TOTAL APPARENT PWR	-	-	-	-	3612.3	
EFFICIENCY (%)	67.4	77.4	79.8	81.0	79.7	

$$EFF = \frac{\text{TOTAL TRUE POWER}}{\text{DC INPUT WATTS}} \times 100$$

REGULATION: 2%

-17B-
I-28

(0.8)

121

AT: 60VDC INPUT
60Hz OUTPUT FREQ

(Output Connected in Parallel Mode of Operation) (1 ϕ , 120V, 60Hz)

LOAD CONDITION	1/4 RATED UNITY	1/2 RATED UNITY	3/4 RATED UNITY	RATED UNITY	RATED INDUCTIVE
DC INPUT	VOLTS	60.0	60.0	60.0	60.0
	AMPS	16.75	32.59	47.6	62.94
	WATTS	1005.0	1955.4	2856.0	3776.4
AC OUTPUT (V ₁)	-	-	-	-	93.8
AC OUTPUT (V ₂)	119.8	119.6	119.6	119.6	119.1
AC OUTPUT AMPS	5.67	12.53	19.72	25.07	30.35
TRUE PWR (V ₂ •A)	679.3	1498.6	2238.9	2998.4	2846.8
PARENT PWR (V ₁ •A)	-	-	-	-	3614.7
P.F. ($\frac{V_2 \cdot A}{V_1 \cdot A}$)	-	-	-	-	.75
EFFICIENCY (%)	67.6	76.6	78.4	79.4	77.6

$$\text{EFF} = \frac{\text{TRUE POWER}}{\text{DC INPUT WATTS}} \times 100$$

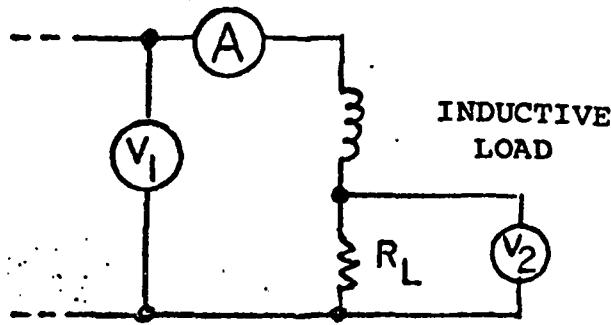
REGULATION: 2%

-120-

EF
3-2
6

I-29

AT: 40VDC INPUT
400Hz OUTPUT FREQ



(Output Connected in 3Ø, 4 Wire Operation)

LOAD CONDITION	1/4 RATED UNITY	1/2 RATED UNITY	3/4 RATED UNITY	RATED UNITY	RATED INDUCTIVE
DC INPUT	VOLTS	40.0	40.0	40.0	40.0
	AMPS	24.78	47.8	69.0	92.5
	WATTS	991.2	1912.0	2760.0	3700
AC OUTPUT VOLTS (V_1)	L1-LO	-	-	-	118.5
	L2-LO	-	-	-	118.7
	L3-LO	-	-	-	118.8
AC OUTPUT VOLTS (V_2)	L1-LO	120.3	120.2	120.0	120.0
	L2-LO	120.1	120.0	120.0	120.0
	L3-LO	120.1	120.1	120.0	120.1
AC OUTPUT AMPS	L1	1.91	4.17	6.19	8.33
	L2	1.93	4.26	6.25	8.41
	L3	1.88	4.13	6.19	8.26
TRUE POWER ($V_2 \cdot A$)	L1	227.8	501.2	742.8	997.6
	L2	231.8	504.0	750.0	1009.2
	L3	225.8	496.0	742.8	992.0
APPARENT POWER ($V_1 \cdot A$)	L1	-	-	-	1173.0
	L2	-	-	-	1158.5
	L3	-	-	-	1174.9
$P.F. \frac{V_2 \cdot A}{V_1 \cdot A}$	L1	-	-	-	.77
	L2	-	-	-	.77
	L3	-	-	-	.77
TOTAL TRUE POWER	687.4	1501.2	2235.6	3000.8	2700.0
TOTAL APPARENT PWR	-	-	-	-	3506.4
EFFICIENCY (%)	69.3	78.5	81.0	81.1	79.6

$$EFF = \frac{\text{TOTAL TRUE POWER}}{\text{DC INPUT WATTS}} \times 100$$

REGULATION: 2%

~~-120-~~
I-30

AS.

AT: 40VDC INPUT
400Hz OUTPUT FREQ

(Output Connected in Parallel Mode of Operation) 1 ϕ , 200 Swin)

LOAD CONDITION	1/4 RATED UNITY	1/2 RATED UNITY	3/4 RATED UNITY	RATED UNITY	RATED INDUCTIVE
DC INPUT	VOLTS	40.0	40.0	40.0	40.0
	AMPS	24.45	47.70	69.6	91.1
	WATTS	978.0	1908.0	2744.0	3676.0
AC OUTPUT (V ₁)	-	-	-	-	117.6
AC OUTPUT (V ₂)	119.9	119.9	119.6	119.5	91.0
AC OUTPUT AMPS	5.67	12.46	18.56	24.85	29.44
TRUE PWR (V ₂ •A)	679.8	1493.9	2217.8	2969.6	2679.0
APPARENT PWR (V ₁ •A)	-	-	-	-	3462.1
P.F. ($\frac{V_2 \cdot A}{V_1 \cdot A}$)	-	-	-	-	.77
EFFICIENCY (%)	69.5	78.3	80.9	80.8	79.0

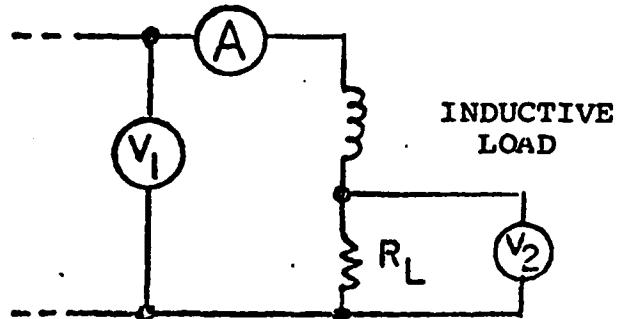
$$EFF = \frac{\text{TRUE POWER}}{\text{DC INPUT WATTS}} \times 100$$

REGULATION: 2%

-17E-

6/26/66

AT: 60VDC INPUT
400Hz OUTPUT FREQ



(Output Connected in 3Ø, 4 Wire Operation)

LOAD CONDITION	1/4 RATED UNITY	1/2 RATED UNITY	3/4 RATED UNITY	RATED UNITY	RATED INDUCTIVE
DC INPUT	VOLTS	60.0	60.0	60.0	60.0
	AMPS	16.99	32.58	46.58	61.75
	WATTS	1019.4	1954.8	2794.8	3717.0
AC OUTPUT VOLTS (V ₁)	L1-L0	-	-	-	118.5
	L2-L0	-	-	-	118.5
	L3-L0	-	-	-	118.5
AC OUTPUT VOLTS (V ₂)	L1-L0	120.0	120.0	119.8	119.7
	L2-L0	119.8	119.7	119.7	119.7
	L3-L0	119.7	119.8	119.8	119.7
AC OUTPUT AMPS	L1	1.90	4.16	6.19	8.33
	L2	1.93	4.19	6.24	8.35
	L3	1.87	4.12	6.18	8.24
TRUE POWER (V ₂ •A)	L1	228.0	499.2	741.6	997.1
	L2	231.2	501.5	746.9	1003.1
	L3	223.8	493.6	740.4	986.3
APPARENT POWER (V ₁ •A)	L1	-	-	-	1172.0
	L2	-	-	-	1151.8
	L3	-	-	-	1168.4
P.F. $\frac{V_2 \cdot A}{V_1 \cdot A}$	L1	-	-	-	.77
	L2	-	-	-	.78
	L3	-	-	-	.77
TOTAL TRUE POWER	683.0	1494.3	2228.8	2996.5	2694.5
TOTAL APPARENT PWR	-	-	-	-	3492.2
EFFICIENCY (%)	67.0	76.4	79.8	80.3	78.5

$$EFF = \frac{\text{TOTAL TRUE POWER}}{\text{DC INPUT WATTS}} \times 100$$

REGULATION: 2%

-17T-

I-32

105.

(0.8)

AT: 60VDC INPUT
400Hz OUTPUT FREQ

(Output Connected in Parallel Mode of Operation) (1φ, 120V, 200W)

LOAD CONDITION		1/4 RATED UNITY	1/2 RATED UNITY	3/4 RATED UNITY	RATED UNITY	RATED INDUCTIVE
DC INPUT	VOLTS	60.0	60.0	60.0	60.0	60.0
	AMPS	16.90	32.27	46.46	61.6	56.6
	WATTS	1014.0	1936.2	2787.6	3696.0	3396.0
AC OUTPUT (V ₁)		-	-	-	-	117.3
AC OUTPUT (V ₂)		119.6	119.5	119.3	119.2	90.0
AC OUTPUT AMPS		5.67	12.43	18.51	24.79	29.44
TRUE PWR (V ₂ •A)		678.1	1485.4	2208.2	2254.9	2649.6
APPARENT PWR (V ₁ •A)		-	-	-	-	3453.0
P.F. ($\frac{V_2 \cdot A}{V_1 \cdot A}$)		-	-	-	-	.77
EFFICIENCY (%)		66.9	76.7	79.2	80.0	78.0

$$EFF = \frac{\text{TRUE POWER}}{\text{DC INPUT WATTS}} \times 100$$

REGULATION: 2%

-17G-

